COPY NO.

TECHNICAL MEMORANDUM 1244

FEASIBILITY STUDY OF SOLID STATE SAFETY AND ARMING DEVICE FOR SQUIBS

RONALD M. GROGAN
PAUL J. KISATSKY

APRIL 1964

AMCMS CODE 5016.11.84401

DA PROJECT 1A0130.01A039

PICATINNY ARSENAL
DOVER, NEW JERSEY

FEASIBILITY STUDY OF SOLID STATE SAFETY & ARMING DEVICE FOR SQUIBS

by

Ronold M. Grogan
Paul J. Kisotsky

April 1964

Feltmon Research Laborotories
Picotinny Arsenol
Dover, N. J.

Technicol Memorandum 1244

AMCMS 5016.11.84401

Dept of the Army Project 1A0130.01A039

Approved:by

S Sage

S. SAGE
Chief, Pyrotechnics
Loborotory

TABLE OF CONTENTS

ABSTRACT

The purpose of this investigation was to determine the feasibility of using the field-effect transistor as a safety device to "short" out electrically activated squibs before they receive a firing pulse. The results of this study indicate that the present "state of the art" of field-effect transistor technology is not sufficiently advanced for the necessary device to be feasible or practical.

INTRODUCTION

Many military applications have need for a safety device that could be used to "short" out electrically activated squibs before they receive a firing pulse. Such a device would be analogous to a switch having two distinct positions. Under normal standby or shelf conditions, the device should present a resistance at least one order less than the resistance of the electric detonator; and upon receiving the firing pulse change to a resistance at least one order higher than that of the detonator.

Most semiconductor devices to date operate with a reverse effect; i.e., they are normally high resistance and upon receipt of a signal, switch to a low resistance. This investigation was initiated to explore a semiconductor device that does have the desired characteristics, the field-effect transistor.

THEORY OF OPERATION

Basically, the field-effect transistor operates on a different principle than conventional transistors. The current conduction is caused by one type of carrier only, and is controlled by a depletion region set up by a reversed bias PN junction. Figure 5 (p 12) shows the characteristics of a typical field-effect transistor. Let us assume that a bar of N type material is used as the current carrier (see Fig 1, p 2). The current carriers are then electrons, and the path is from the ground (or source), through the N type material to the drain, and then through the load back to the source. The resistance of this N material must be a maximum of .1 ohm to effectively

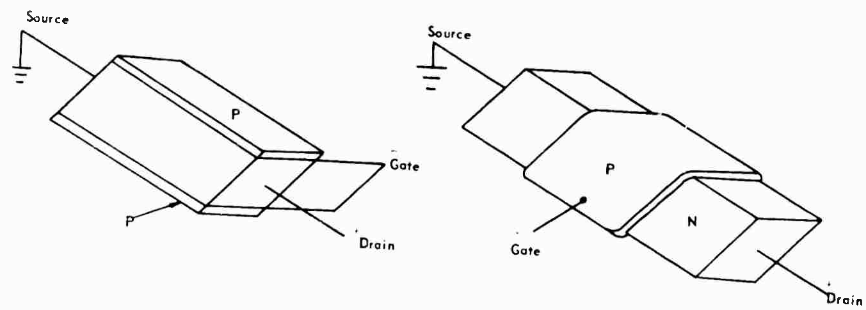

Fig 1 Two types of field-effect transistor construction

"safe" the squib. Either two connected layers (Case 1) or an encircling belt (Case 2) of P-type material is used to control the current conduction of the N-type material. This control is achieved by reverse-biasing the PN junction and controlling the width of the depletion layer formed by the junction, to effectively vary the resistance of the channel.

The principle of operation of the field-effect transistor makes it necessary that the depletion region extend much further into the N region than into the P region. To attain this relationship, the N region is made larger in volume than the P region, and the P region is heavily doped to obtain the necessary equality of charge carriers. A closer look at the depletion region under these conditions shows that this region is very small in the P material, and can be considered negligible.

To determine the theoretical limits (if any) of this approach to a safety and arming device for squibs, it is necessary to examine the current through the N material as a function of the voltage across it. The maximum current will flow when no voltage is applied to the gate. This is the case of interest; hence, the following work will be done under this condition ($V_g = 0$).

With a voltage applied to the drain, the potential across the junction increases from the source end to the drain end. This causes the depletion region to extend farther into the N region at the drain end than at the source end. If we assume that the channel narrows gradually (Ref 2), we may neglect the field in the y direction within the channel (see Fig 2, p 3).

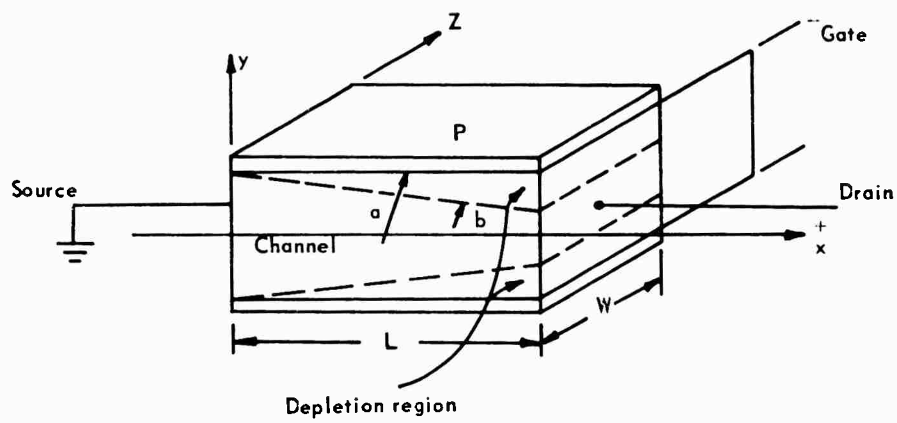

Fig 2 Field-effect transistor showing depletion region (Case 1)

This means that the electric field in the y direction is confined to the depletion region. We may now apply Poisson's equation of continuity for electrostatics which says that the divergence of the electric field is equal to the charge density. This may be expressed mathematically (in one dimension) as

$$k \frac{dE}{dy} = q N_d$$

where k is the actual dielectric constant, E is the electric field, and $q N_d$ is the charge density (q = electronic charge, N_d = effective doping density). Referring to the respective figures and following this notation, we may develop a solution for the current as a function of V_{drain} for each of the two cases.

Case 1

For the case of two layers of P material on opposite sides of the bar of N material, the channel is shown in Figure 2. With no voltage applied to the terminals, a depletion region will be established as in any PN junction.

$$k \frac{d^2V}{dy^2} = k \frac{dE}{dy} = q N_d$$

$$\frac{dE}{dy} = \frac{q N_d}{k}$$

$$E = \frac{q N_d}{k} y + C$$

From $y = 0$ to $y = b$ no field exists, since the field in the y direction is confined to the depletion region.

Therefore

$$C = -\frac{q N_d b}{k}$$

$$E = \frac{q N_d}{k} (y - b) \quad \text{(in the depletion region only)}$$

$$b < y < a$$

To get the potential

$$V = \int E\, dy = \frac{q N_d}{k} \int (y - b)\, dy$$

$$= q N_d \left[\frac{y^2}{2} - by + C \right]$$

at

$$y = a \qquad V = 0 \qquad \text{(P region grounded)}$$

Therefore

$$C = ba - \frac{a^2}{2}$$

$$V = \frac{q N_d}{k} \left[\frac{y^2}{2} - by + ba - \frac{a^2}{2} \right]$$

The voltage across the barrier is V_{ab} $(y = b)$

$$V_{ab} = \frac{q N_d}{k} \left[-\frac{b^2}{2} - b^2 + ba - \frac{a^2}{2} \right]$$

$$= -q \frac{N_d}{2k} [a - b]^2 \qquad (1)$$

The voltage at which the channel is completely blocked is at $b = 0$

$$V \text{ pinch-off}_{(b = 0)} = -\frac{q N_d}{2k} a^2 \qquad (2)$$

The pinch-off voltage is a characteristic of the device and may be reached by either reverse biasing the gate or applying a voltage of sufficient magnitude to the drain, or taking these two steps in any combination. The expression for the voltage across the barrier shows the dependence of the width of the depletion region (b) on this voltage. On the basis of the assumption that no current flows in the gate lead at $V_g = 0$ (which is the case for maximum current in the N bar), we may now describe the current through the N-type semiconductor material as a function of the voltage impressed on the drain. The current from the source must equal the current into the drain, and a voltage drop must exist along the bar of N material. The current indicates an electric field in the X direction. Looking into the drain end of the bar, we will have a current flowing into the plane of the paper. The differential resistance of the channel is

$$dr = \frac{\rho \, d_X}{2Wb}$$

where, rearranging Equation 1 above and solving for b,

$$V = \frac{q N_d a^2}{2k} \left[1 - \frac{b}{a} \right]^2$$

$$= V_0 \left[1 - \frac{b}{a} \right]^2$$

$$b = a \left[1 - \left(\frac{V}{V_0} \right)^{1/2} \right] \qquad (3)$$

Still assuming that $V_g = 0$ and using the relationship which shows how b varies with V (W is a constant), then

$$dr = \frac{\rho\, dx}{2\, W\, a \left[1 - \left(\frac{V}{V_0}\right)^{1/2}\right]}$$

Also, knowing that $I\,dr = dV$,

$$I \frac{\rho\, dx}{2\, W\, a \left[1 - \left(\frac{V}{V_0}\right)^{1/2}\right]} = dV$$

$$I \int_0^L dx = \frac{2\, W\, a}{\rho} \int_0^{V_d} \left[1 - \left(\frac{V}{V_0}\right)^{1/2}\right] dV$$

$$I = \frac{2\, W\, a}{\rho\, L}\, V_d \left[1 - \frac{2}{3}\left(\frac{V_d}{V_0}\right)^{1/2}\right] \qquad (4)$$

Where

W	= width of device	a	= ½ height of N bar
L	= length of device	ρ	= resistivity of N bar
V_0	= pinch-off voltage	V_d	= voltage applied to drain

Note: This equation may only be plotted up to the point at which pinch-off occurs. After this, the gradual approximation no longer holds. The near horizontal continuation of these lines (Fig 4, p 10) assumes a simple saturation condition, which is a good approximation in practical devices.

Case 2

For a square bar surrounded by a belt of P material, the channel will be a square cross-section with area decreasing with length L.

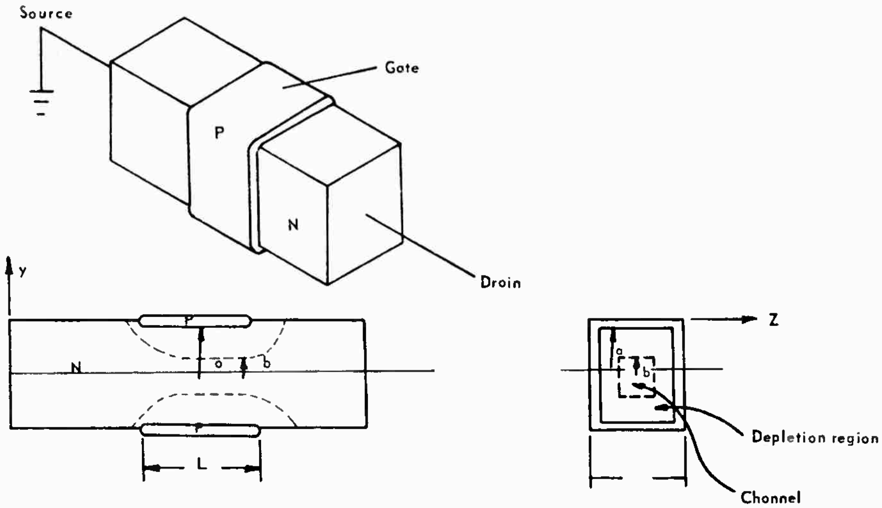

Fig 3 Field-effect transistor showing depletion region (Case 2)

Then

$$dr = \frac{\rho\, dx}{4b^2}$$

$$= \frac{\rho\, dx}{4\, a^2 \left[1 - \left(\frac{V}{V_0}\right)^{1/2}\right]^2}$$

$$Idr = dV$$

$$Idx = \frac{4\, a^2}{\rho} \left[1 - \left(\frac{V}{V_0}\right)^{1/2}\right]^2$$

Integrating with known limits, x goes from 0 to L and V goes from 0 to V_d

$$I L = \frac{4a^2}{\rho} \left[\int_0^{V_d} V - \frac{4}{3} \frac{V^{3/2}}{V_0^{1/2}} + \frac{V^2}{2V_0} \right]$$

$$I = \frac{4a^2 V_d}{\rho L} \left[1 - \frac{4}{3} \left(\frac{V_d}{V_0} \right)^{1/2} + \frac{V_d}{2V_0} \right] \tag{5}$$

where

I = current through channel

a = ½ height of N region

V_d = V drain

L = length of P region

ρ = resistivity of N region

V_0 = pinch-off voltage = $\frac{q N_d}{2k} (a)^2$

q = charge of electron

N_d = number of donors/cm³

k = actual dielectric constant

From Equation 4, on p 6

$$I = 2 \frac{W a}{\rho L} V_d \left[1 - \frac{2}{3} \left(\frac{V_d}{V_0} \right)^{1/2} \right]$$

It is apparent that Case 1 will allow a higher current for a specified geometry and voltage than Case 2. Case 2 will allow a greater rate of change of channel current with applied voltage, but this application requires the highest current for given parameters; therefore, Case 1 is more advantageous, and will be the topic of future discussion.

From Equation 4, to maximize I

a and W should be maximized

L, ρ, and $\frac{V_d}{V_o}$ should be minimized

As we investigate each of these terms for optimum theoretical values, it must be realized that practical values also exist. The resistivity "ρ" has theoretical limits that can be approached in practice. Let us use the lower limit for the resistivity of the P layers as .001 ohm-cm. To validate the approximation that the depletion region falls mostly in the N bar, we must have a higher value of resistivity in the N bar, say .03 ohm-cm. A practical value of V_o is difficult to predict, without knowledge of a specific use, but a value of 500 volts should suffice for sample calculations. Shockley (Ref 2) has shown that the length (L) of the bar should be at least twice the height of the N region (a) to validate the assumption that the field in the y direction is confined to the depletion region. The device, in general, should present an impedance of .1 ohm or less to any signal impressed across it until such time as the gate function is reverse biased. This means that V_o should be much higher than any signal impressed on the drain, and that the gate signal should be of sufficient magnitude to effectively increase the resistance of the bar by at least two orders of magnitude. If we assume the following values:

$$\rho_N = .03 \text{ ohm-cm}$$

$$V_o = 500 \text{ volts}$$

$$L = 2a$$

$$\frac{V_d}{V_o} = \frac{100}{500} \text{ volts} = .2$$

$$W = 1 \text{ cm}$$

then

$$I = \frac{W\, V_d}{\rho}\left[1 - \frac{2}{3}\left(\frac{V_d}{V_o}\right)^{1/2}\right]$$

$$= \frac{1\text{ cm }(100)}{(.03)\text{ ohm-cm}}\left[1 - \frac{2}{3}\,(.2)^{1/2}\right]$$

$$\simeq 2300 \text{ amps}$$

Then the effective resistance is approximately $\frac{100}{2300} \simeq .043$ ohm.

The dimension a then must be calculated from the equation for V_o.

$$V_o = \frac{q\, N_d\, a^2}{2K}$$

$$a = \left(\frac{2K\, V_o}{q\, N_d}\right)^{1/2}$$

$$= 1.1 \times 10^{-4} \text{ cm}$$

$$L = 2a = 2.2 \times 10^{-4} \text{ cm}$$

The geometry of the device will then be as shown in Figure 4.

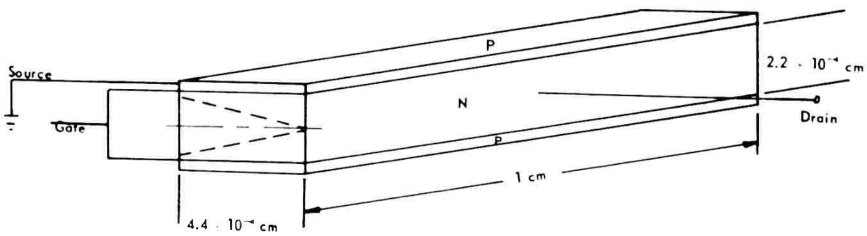

Fig 4 Geometry of theoretical device

Though this device is theoretically realizable, according to the above work, it is not practical. The leading manufacturers of field-effect transistors were contacted and all agreed that the device was not feasible. The major limitation appears to be the present "state of the art" capabilities in field-effect transistor technology. Present day devices of this type are in the resistance range of 200-5000 ohms. The geometry of the device necessary to achieve the substantially lower resistance is not compatible to present day processes. It appears that the large junction areas necessary give rise to imperfections and nonuniformity, causing low yield and high cost. Ohmic contacts at the source and drain also contribute to the resistance of the device. Lastly, certain assumptions and approximations made in the analysis are not met in practice. Crystalonics, Inc., one of the major producers of field-effect transistors, indicated that future improvements in materials and processes could make such a device feasible.

CONCLUSION

It is concluded that the field-effect transistor approach to a safety and arming device for electrically activated "squibs" is not feasible at present. This does not mean that a device such as this could not be prepared in laboratory or breadboard form, but that the effort and cost involved make any attempt to produce an end-item type device impractical just now. Future improvements in materials and processes could make such a device feasible, but the present "state of the art" in preparing field-effect transistors is not at the stage where devices of the necessary low resistance could be considered practical.

REFERENCES

1. Hunter, Lloyd P., *Handbook of Semiconductor Electronics*, McGraw-Hill Book Co., 1956, p 4.29

2. Shockley, W., "A Unipolar 'Field-Effect' Transistor," *Proceedings of the I.R.E. 40,* 11, November 1952, p 1365

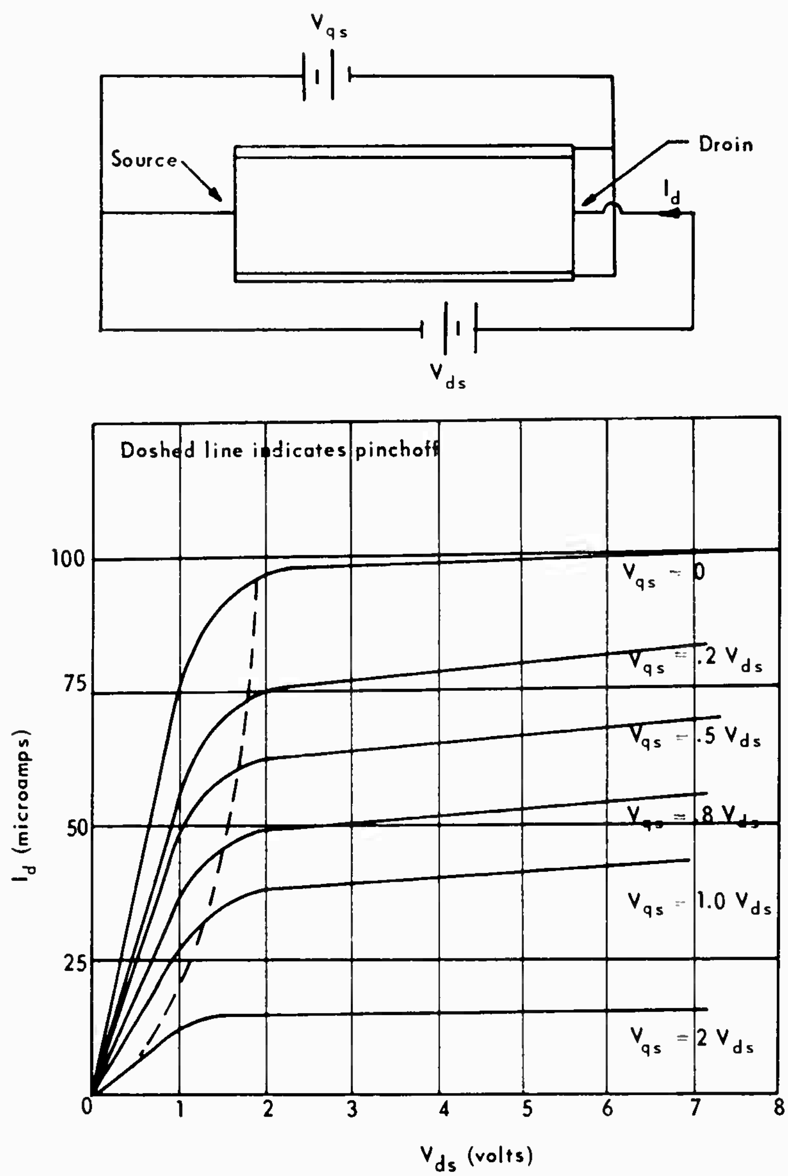

Fig 5 Typical output characteristics of field-effect transistors

DISTRIBUTION LIST

	Copy No.
Commanding Officer Picatinny Arsenal ATTN: Technical Information Branch Dover, N. J.	1 - 5
Commanding General U. S. Army Munitions Command ATTN: AMSMU-RE AMSMU-Q Dover, N. J.	6 7
Defense Documentation Center Cameron Station Alexandria, Virginia	8 - 27
U. S. Naval Ordnance Laboratory ATTN: Technical Library White Oak Silver Spring, Maryland	28
Dept of the Navy Bureau of Naval Weapons Washington 25, D. C.	29
Commanding Officer Harry Diamond Laboratories ATTN: Library, Room 211, Bldg 92 Washington 25, D. C. 20438	30
Commanding Officer Frankford Arsenal ATTN: Library Branch, 0270 Bridge & Tacony St. Philadelphia 37, Pa.	31

	Copy No.
Redstone Scientific Information Center U. S. Army Missile Command ATTN: Chief, Document Section Redstone Arsenal Alabama	32
Scientific and Technical Information Facility ATTN: NASA Representative (S-AK/DL) P. O. Box 5700 Bethesda, Maryland	33
Commandant U. S. Army Ordnance Center and School ATTN: AISO-SL Aberdeen Proving Ground Maryland 21005	34
Director, Feltman Research Laboratories	35
Chief, W & SP Laboratory	36
Chief, Artillery Ammunition Laboratory	37
Chief, Technical Services Laboratory	38
Chief, Tactical Atomic Warheads Laboratory	39
Chief, Long Range Atomic Warheads Laboratory	40
Chief, Atomic Ammunition Development Laboratory	41
Chief, Pyrotechnics Laboratory	42 - 46
Chief, Engineering Sciences Laboratory	47

AD __________ Accession No. __________

Picatinny Arsenal, Dover, N. J.

FEASIBILITY STUDY OF SOLID STATE SAFETY & ARMING DEVICE FOR SQUIBS

Ronald M. Grogan, Paul J. Kisatsky

Technical Memorandum 1244, April 1964, 14 pp, figures. DA Proj 1A0130.01A039, AMCMS 5016.11.84401. Unclassified Memorandum

The purpose of this investigation was to determine the feasibility of using the field-effect transistor as a safety device to "short" out electrically activated squibs before they receive a firing pulse. The results of this study indicate that the present "state of the art" of field-effect transistor technology is not sufficiently advanced for the necessary device to be feasible or practical.

1. Electric detonators — Safety & arming devices
2. Safety and arming devices
3. Transistors

I. Grogan, R. M.
II. Kisatsky, P. J.
III. Title: Solid... squibs

UNITERMS

Squib, Electric, Detonator, Safety, Arm, Device, Transistor, Solid, State, Grogan, R. M., Kisatsky, P. J.

AD __________ Accession No. __________

Picatinny Arsenal, Dover, N. J.

FEASIBILITY STUDY OF SOLID STATE SAFETY & ARMING DEVICE FOR SQUIBS

Ronald M. Grogan, Paul J. Kisatsky

Technical Memorandum 1244, April 1964, 14 pp, figures. DA Proj 1A0130.01A039, AMCMS 5016.11.84401. Unclassified Memorandum

The purpose of this investigation was to determine the feasibility of using the field-effect transistor as a safety device to "short" out electrically activated squibs before they receive a firing pulse. The results of this study indicate that the present "state of the art" of field-effect transistor technology is not sufficiently advanced for the necessary device to be feasible or practical.

1. Electric detonators — Safety & arming devices
2. Safety and arming devices
3. Transistors

I. Grogan, R. M.
II. Kisatsky, P. J.
III. Title: Solid... squibs

UNITERMS

Squib, Electric, Detonator, Safety, Arm, Device, Transistor, Solid, State, Grogan, R. M., Kisatsky, P. J.

AD __________ Accession No. __________

Picatinny Arsenal, Dover, N. J.

FEASIBILITY STUDY OF SOLID STATE SAFETY & ARMING DEVICE FOR SQUIBS

Ronald M. Grogan, Paul J. Kisatsky

Technical Memorandum 1244, April 1964, 14 pp, figures. DA Proj 1A0130.01A039, AMCMS 5016.11.84401. Unclassified Memorandum

The purpose of this investigation was to determine the feasibility of using the field-effect transistor as a safety device to "short" out electrically activated squibs before they receive a firing pulse. The results of this study indicate that the present "state of the art" of field-effect transistor technology is not sufficiently advanced for the necessary device to be feasible or practical.

1. Electric detonators — Safety & arming devices
2. Safety and arming devices
3. Transistors

I. Grogan, R. M.
II. Kisatsky, P. J.
III. Title: Solid... squibs

UNITERMS

Squib, Electric, Detonator, Safety, Arm, Device, Transistor, Solid, State, Grogan, R. M., Kisatsky, P. J.

AD __________ Accession No. __________

Picatinny Arsenal, Dover, N. J.

FEASIBILITY STUDY OF SOLID STATE SAFETY & ARMING DEVICE FOR SQUIBS

Ronald M. Grogan, Paul J. Kisatsky

Technical Memorandum 1244, April 1964, 14 pp, figures. DA Proj 1A0130.01A039, AMCMS 5016.11.84401. Unclassified Memorandum

The purpose of this investigation was to determine the feasibility of using the field-effect transistor as a safety device to "short" out electrically activated squibs before they receive a firing pulse. The results of this study indicate that the present "state of the art" of field-effect transistor technology is not sufficiently advanced for the necessary device to be feasible or practical.

1. Electric detonators — Safety & arming devices
2. Safety and arming devices
3. Transistors

I. Grogan, R. M.
II. Kisatsky, P. J.
III. Title: Solid... squibs

UNITERMS

Squib, Electric, Detonator, Safety, Arm, Device, Transistor, Solid, State, Grogan, R. M., Kisatsky, P. J.

AD____________ Accession No. ____________

Picatinny Arsenal, Dover, N. J.

FEASIBILITY STUDY OF SOLID STATE SAFETY & ARMING DEVICE FOR SQUIBS

Ronold M. Grogon, Paul J. Kisotsky

Technical Memorandum 1244, April 1964, 14 pp, figures. DA Proj 1A0130.01A039, AMCMS 5016.11.84401. Unclassified Memorandum

The purpose of this investigation was to determine the feasibility of using the field-effect transistor as a safety device to "short" out electrically activated squibs before they receive a firing pulse. The results of this study indicate that the present "state of the art" of field-effect transistor technology is not sufficiently advanced for the necessary device to be feasible or practical.

( )

1. Electric detonators — Safety & arming devices
2. Safety and arming devices
3. Transistors

I. Grogan, R. M.
II. Kisatsky, P. J.
III. Title: Solid... squibs

UNITERMS

Squib	Electric
Detonator	Safety
Arm	Device
Transistor	Solid
State	
Grogan, R. M.	
Kisatsky, P. J.	

AD____________ Accession No. ____________

Picatinny Arsenal, Dover, N. J.

FEASIBILITY STUDY OF SOLID STATE SAFETY & ARMING DEVICE FOR SQUIBS

Ronold M. Grogan, Paul J. Kisatsky

Technical Memorandum 1244, April 1964, 14 pp, figures. DA Proj 1A0130.01A039, AMCMS 5016.11.84401. Unclassified Memorandum

The purpose of this investigation was to determine the feasibility of using the field-effect transistor as a safety device to "short" out electrically activated squibs before they receive a firing pulse. The results of this study indicate that the present "state of the art" of field-effect transistor technology is not sufficiently advanced for the necessary device to be feasible or practical.

( )

1. Electric detonators — Safety & arming devices
2. Safety and arming devices
3. Transistors

I. Grogan, R. M.
II. Kisatsky, P. J.
III. Title: Solid... squibs

UNITERMS

Squib, Electric, Detonator, Safety, Arm, Device, Transistor, Solid, State, Grogan, R. M., Kisatsky, P. J.

AD____________ Accession No. ____________

Picatinny Arsenal, Dover, N. J.

FEASIBILITY STUDY OF SOLID STATE SAFETY & ARMING DEVICE FOR SQUIBS

Ronald M. Grogan, Paul J. Kisatsky

Technical Memorandum 1244, April 1964, 14 pp, figures. DA Proj 1A0130.01A039, AMCMS 5016.11.84401. Unclassified Memorandum

The purpose of this investigation was to determine the feasibility of using the field-effect transistor as a safety device to "short" out electrically activated squibs before they receive a firing pulse. The results of this study indicate that the present "state of the art" of field-effect transistor technology is not sufficiently advanced for the necessary device to be feasible or practical.

1. Electric detonators — Safety & arming devices
2. Safety and arming devices
3. Transistors

I. Grogan, R. M.
II. Kisatsky, P. J.
III. Title: Solid...squibs

UNITERMS

Squib, Electric, Detonator, Safety, Arm, Device, Transistor, Solid, State, Grogan, R. M., Kisatsky, P. J.

AD____________ Accession No. ____________

Picatinny Arsenal, Dover, N. J.

FEASIBILITY STUDY OF SOLID STATE SAFETY & ARMING DEVICE FOR SQUIBS

Ronold M. Grogan, Paul J. Kisatsky

Technical Memorandum 1244, April 1964, 14 pp, figures. DA Proj 1A0130.01A039, AMCMS 5016.11.84401. Unclassified Memorandum

The purpose of this investigation was to determine the feasibility of using the field-effect transistor as a safety device to "short" out electrically activated squibs before they receive a firing pulse. The results of this study indicate that the present "state of the art" of field-effect transistor technology is not sufficiently advanced for the necessary device to be feasible or practical.

( )

1. Electric detonators — Safety & arming devices
2. Safety and arming devices
3. Transistors

I. Grogan, R. M.
II. Kisatsky, P. J.
III. Title: Solid...squibs

UNITERMS

Squib, Electric, Detonator, Safety, Arm, Device, Transistor, Solid, State, Grogan, R. M., Kisatsky, P. J.

AD ________________ Accession No. ________________

Picatinny Arsenal, Dover, N. J.

FEASIBILITY STUDY OF SOLID STATE SAFETY & ARMING DEVICE FOR SQUIBS

Ronald M. Gragan, Paul J. Kisatsky

Technical Memorandum 1244, April 1964, 14 pp, figures. DA Proj 1A0130.01A039, AMCMS 5016.11.84401. Unclassified Memorandum

The purpose of this investigation was to determine the feasibility of using the field-effect transistor as a safety device to "short" out electrically activated squibs before they receive a firing pulse. The results of this study indicate that the present "state of the art" of field-effect transistor technology is not sufficiently advanced for the necessary device to be feasible or practical.

1. Electric detonators — Safety & arming devices
2. Safety and arming devices
3. Transistors

I. Grogan, R. M.
II. Kisatsky, P. J.
III. Title: Solid... squibs

UNITERMS

Squib	Electric
Detonator	Safety
Arm	Device
Transistor	Solid
State	
Grogan, R. M.	
Kisatsky, P. J.	

AD ________________ Accession No. ________________

Picatinny Arsenal, Dover, N. J.

FEASIBILITY STUDY OF SOLID STATE SAFETY & ARMING DEVICE FOR SQUIBS

Ronald M. Gragan, Paul J. Kisatsky

Technical Memorandum 1244, April 1964, 14 pp, figures. DA Proj 1A0130.01A039, AMCMS 5016.11.84401. Unclassified Memorandum

The purpose of this investigation was to determine the feasibility of using the field-effect transistor as a safety device to "short" out electrically activated squibs before they receive a firing pulse. The results of this study indicate that the present "state of the art" of field-effect transistor technology is not sufficiently advanced for the necessary device to be feasible or practical.

1. Electric detonators — Safety & arming devices
2. Safety and arming devices
3. Transistors

I. Grogan, R. M.
II. Kisatsky, P. J.
III. Title: Solid... squibs

UNITERMS

Squib, Detonator, Arm, Transistor, State, Grogan, R. M., Kisatsky, P. J., Electric, Safety, Device, Solid

AD ________________ Accession No. ________________

Picatinny Arsenal, Dover, N. J.

FEASIBILITY STUDY OF SOLID STATE SAFETY & ARMING DEVICE FOR SQUIBS

Ronald M. Gragan, Paul J. Kisatsky

Technical Memorandum 1244, April 1964, 14 pp, figures. DA Proj 1A0130.01A039, AMCMS 5016.11.84401. Unclassified Memorandum

The purpose of this investigation was to determine the feasibility of using the field-effect transistor as a safety device to "short" out electrically activated squibs before they receive a firing pulse. The results of this study indicate that the present "state of the art" of field-effect transistor technology is not sufficiently advanced for the necessary device to be feasible or practical.

1. Electric detonators — Safety & arming devices
2. Safety and arming devices
3. Transistors

I. Grogan, R. M.
II. Kisatsky, P. J.
III. Title: Solid...squibs

UNITERMS

Squib, Detonator, Arm, Transistor, State, Grogan, R. M., Kisatsky, P. J., Electric, Safety, Device, Solid

AD ________________ Accession No. ________________

Picatinny Arsenal, Dover, N. J.

FEASIBILITY STUDY OF SOLID STATE SAFETY & ARMING DEVICE FOR SQUIBS

Ronald M. Gragan, Paul J. Kisatsky

Technical Memorandum 1244, April 1964, 14 pp, figures. DAProj 1A0130.01A039, AMCMS 5016.11.84401. Unclassified Memorandum

The purpose of this investigation was to determine the feasibility of using the field-effect transistor as a safety device to "short" out electrically activated squibs before they receive a firing pulse. The results of this study indicate that the present "state of the art" of field-effect transistor technology is not sufficiently advanced for the necessary device to be feasible or practical.

1. Electric detonators — Safety & arming devices
2. Safety and arming devices
3. Transistors

I. Grogan, R. M.
II. Kisatsky, P. J.
III. Title: Solid...squibs

UNITERMS

Squib, Detonator, Arm, Transistor, State, Grogan, R. M., Kisatsky, P. J., Electric, Safety, Device, Solid